

When Graduates aren't as good as they think? – A study of overconfidence in numerical skills among British graduates

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Abstract

The experiment tested overconfidence in number skills among graduates and non-graduates. The data was collected on a residential management training programme for part-time professional students; half had a degree and half didn't. The research aimed to test whether graduate professionals, due to higher qualifications, overstated their numerical abilities compared to non-graduates. The experiment, conducted using E-prime, showed a significant interaction between the level of qualification and overstatement of numerical abilities. The results support the hypotheses and showed that graduate professionals rated themselves higher than their actual abilities. The performance of graduates in the numerical test wasn't consistent with their confidence estimates. The findings are significant for rethinking higher education curricula which are currently under pressure to align with the needs of the economy. We advocate more inclusive and interpretive research for greater understanding of the issues to offer useful data to policymakers and higher education institutions in preparing graduates for work and decision-making. A critical contribution of this study is to have actually tested the numerical abilities of graduates and not relied exclusively on employer feedback to draw conclusions, thus providing some hard evidence.

Key words: overconfidence, graduates employability, numeracy skills, higher education, universities

Introduction

Graduate employability has been high on both government and the higher education agendas for the past two decades in the UK and the developed world generally. There is more and more concern that while graduates acquire significant subject knowledge when they leave universities and colleges, an important proportion of them may lack basic skills. Some of the areas considered to be areas in which graduates lack skills centre on planning, information technology (IT), literacy and communication (Shultz, 2008; Raybould & Sheedy, 2005). Numeracy is a critical skill required if graduates were to typify other employer requirements such as project management, planning and ability to work with uncertainty (Black and Yasukawa, 2010; Raybould & Sheedy, 2005). However, the Financial Times (2015) reports on an OECD study in the same year which shows that United States (US) and United Kingdom (UK) graduates are weaker on literacy and numeracy than their peers from other developed nations. A study by Kuczera, Field and Windisch (2016) confirmed this picture when it found that over 9 million adults in the UK have low basic skills, mainly in the areas of numeracy and literacy. Despite these figures, when graduates are interviewed they appear to display confidence that is at odds with the research evidence. This may lead to view the attitudes and responses of the graduates as an expression of overconfidence.

Overconfidence has emerged as an important area in cognitive psychology. It is an area within the much researched field of judgement and decision making which has fascinated and captivated the imagination of cognitive psychologists for a few decades now. Much of the literature on judgement and decision-making acknowledges that while we cannot necessarily teach people how to make decisions based on objective quantity (Ayton, in Braisby & Gellatly, 2005), it is important to understand people's own 'rationality' for choosing one solution over another. Psychological research in decision-making aims to bridge the gap between normative and descriptive approaches to decision-making, i.e. help people make better decisions. Overconfidence can present difficulties for learning in the sense that it can operate as a barrier to recognising personal

needs as was found in Anzalone's (2009) study among teenage learners in the USA.

The aim of the research is to assess the degree to which the expressed confidence of graduates in numerical skills is exemplified in their capabilities in practice. The main question of the research was: 'Do university graduates overestimate their abilities to deal with numbers due to higher level education experience?' The research pursues three objectives: (1) To assess graduates and non-graduates evaluation of their own skills in numeracy; (2) To determine whether a higher level education (particularly completion of higher education) leads to overconfidence about number skills; (3) To test whether the level of overconfidence experiences variations with levels of difficulty of the numerical test questions. The research design developed three hypotheses: (a) Graduates are more likely than non-graduates to over-rate their basic mathematical skills and use graduate status to legitimise such a claim; (b) Graduates' real basic mathematical skills can be lower than their estimates of skills; (c) In a basic number test, the performance of graduates may not be higher than that their non-graduate counterparts.

The research examines Brunswik's (1955) theory of overconfidence. Using a simple test of confidence with numbers, the research attempts to establish whether graduates and non-graduates show the overconfidence effect (i.e. if the confident judgements about their mathematical abilities are larger than the average of right answers that they produce in a simple numerical test). The study seeks to establish whether the fact of possessing higher qualifications leads graduates to overestimate their basic mathematical skills compared to those who do not have a university degree.

Literature review

Perspectives on overconfidence

Studies of overconfidence examined whether people know as much as they claim to. In other terms, raises the question of whether people do not suffer from over inflation of self-value when rating their own knowledge of reality (Chiu

& Klassen, 2010; Christensen-Szalanski & Bushyhead, 1981). For Harvey (1997) this means people's judgements and decisions are based on their own estimates or probabilities that particular outcomes will materialise. Such estimates are quantified by cognitive psychologist researchers with rates between 0 - 100% (which are referred to as full-range tasks) or often between 50 - 100% (which are also referred to as half-range tasks).

Research using these rating scales found that, in general, when presented with two items and asked to choose the right answer and rate their level of confidence (or certainty) people tend to rate themselves higher than they could produce actual right answers. This is a bias that is, for Gigerenzer, Hoffrage & Kleinbolting (1991), a manifestation of overconfidence. Research in the field also claims that the harder the question the less overconfident people become. This proposition implies that people are more overconfident for simple (easy) questions and are more realistic with estimates about their knowledge of more difficult questions. Within the context of overconfidence research, this has been termed the Hard-Easy Effect (Brunswick, 1955).

Overconfidence and learning

The significance of the study of overconfidence in education is evidenced by a number of studies. For instance, Anzoline (2009) found that overconfidence could impair learning in students because it creates a false sense of knowledge which leads the learner to disengage with the learning process. Similar findings appear in Gustavson & Niall's (2011) study graduates' confidence in research skills. These authors found in their survey that students who rated their research skills as expert level scored only 50% in the research skills test, which is lower than the score of the students who rated themselves as only good. Gustavson & Niall's (2011) results showed overconfidence in research skills. Chiu & Klassen (2010: 3) posit that overconfidence (which they refer to as overestimation) of "one's potential performance or self-efficacy can lead to poor preparation and lower performance". Similar findings are reported by Ackerman & Wolman (2007). In the context of employment and organisations, namely in the financial sector, the negative consequences of overconfidence have been elaborated on by Menkhoffa, Schmidta & Brozynskiab (2006). They found that

less experienced fund managers had higher returns than those who had longer length of service due to the latter developing overconfidence and complacency over the years while the former did not take anything for granted and therefore deployed greater diligence. De la Rosa et al.'s (2011) study about "Overconfidence and moral hazard" yielded some very similar results, which asserted that "an overconfident agent disproportionately values success-contingent payments" (p. 429). This is consistent with Brunswick's (1955) 'hard-easy effect' since familiar tasks in their experience are treated by the experienced agent as 'easy' tasks that can be completed with minimum effort. These studies demonstrated that overconfidence is an ill with far-reaching negative consequences and is therefore worth tackling vigorously at personal and institutional levels.

The overconfidence shown by students generally poses a problem for the higher education system and employers because it blurs potential support mechanisms to attain greater basic skills in graduates and improve their employability. Black & Yasukawa (2010) found low levels of literacy and numeracy among adults, including graduates. Yet, Durrani & Tariq (2012) stress the significance of developing numerical skills in undergraduates, pointing out that such skills have become core employability skills and essential selection criteria in the modern labour markets and in the knowledge economy (Browne 2010). Given such critical findings with far reaching implications the need for sustained investigations into how greater numerical literacy could be developed by graduates is no longer argued. These findings are echoed by Hernández-Fernaud et al. (2017) and the LSC (2006).

Impact of overconfidence in numeracy on employability

Hillage and Pollard (1998) define employability not just in terms of being employed after graduation but also in terms of the graduate's ability to secure and hold on to a job in an increasingly competitive market place. With millions of graduates exiting universities every year, the competitiveness of the aspiring professional is no longer established only with the classification of their degree, nor the subject studied. However, important extra-curricular activities and skills gained have become assets (Poole and Sewell, 2007) that employers seek in

a good graduate. While soft skills feature high on the requirements of modern employers, Pegg et al. (2012) and Black & Yasukawa (2010) found that numeracy is equally high on the employers' prime list of graduate assets. Pegg et al. (2012), in particular, found that since 2010 higher education institutions in England have been "required to articulate their position in relation to student employability through the provision of an 'employability statement'".

Adult basic skills particularly in numeracy and literacy have been the subject of debate in the UK for several decades. Kuczera, Field and Windisch (2016) found that in excess of 9 million adults in the UK lack numeracy. This figure includes a sizeable proportion of those completing university education. In fact, the Financial Times (2015), reporting on an earlier OECD research, exposed the evidence that British graduates' level of numeracy is below that of graduates from several competing nations of the developed world. This is a surprising finding since the OECD recorded in 2013 that the number of young people Not in Education, Employment or Training (NEET) has not changed in the current decade and is higher than that of a significant number of European Union countries. Faced with such apparent contradictions between reality and research findings, it is important to undertake further inclusive and interpretive research (Karadağ, 2017) which could be useful to policy makers and higher education establishment alike.

There has been sustained research connecting employability skills, especially numeracy, with productivity (Álvarez-González, López-Miguens & Caballero, 2017; Keep, Mayhew and Payne, 2006; Huselid, 1995). The Learning & Skills Council (LSC) which works with employers and communities to improve skills in England and Wales acknowledged that there are skills gaps in the UK. There is some consensus that investment in the development of basic skills is a pre-condition for steering and maintaining productivity (LSC, 2006; House of Commons, 2015; Kuczera, Field and Windisch (2016). Other studies advocate a link between employee creativity, organisation innovation and performance. For instance, supporting the skills-productivity link, Dedahanov, Rhee & Yoon (2017: 343) contend that "in dynamic marketplaces, innovativeness is necessary to create and sustain superior performance" and this is partly

through the effectiveness of a numerate and skilled workforce. Studying graduate level of numeracy in particular and basic skills in general, is a significant step in attaining greater organisational performance and national productivity. Huizinga et al. (2008) refer to other studies which posit that “patients with low numeracy skills had greater difficulty interpreting food labels” (p. 1966). The authors contend that numeracy does not have only economic or productivity consequences but also health issues. They established a correlation between low numeracy and obesity.

Criticality of numerical skills and professional & managerial effectiveness

The ‘application of number’ is of six critical key skills including - communication, number application, IT, working with others, improving own learning & performance and problem solving - identified by employers in a research by Dench, Perryman & Giles (1998) for the Institute of Employment Studies (IES) in the UK. Employers believe that these skills are inextricably linked to the individual’s performance in the workplace. The concern about numerical skills has been running through various studies and report in the late twentieth and the early twenty-first centuries. For example,

Hazucha, Hezlett and Schneider (1993) found that the ability to analyse financial and numerical data was one of the critical skills for managerial effectiveness, confirming Kanungo and Misra’s (1992) findings which established numerical skills as part of what the authors termed managerial resourcefulness. More recent studies such as those of Rees & Porter (2001), Rajadhyaksha, (2005); Schultz (2008), Maxwell et al. (2009), Carvalho & Rabechini (2015). Maxwell et al. (2009), in particular, raise the issue of the gap between what employers need from postgraduates and the actual skills that they bring on graduation. The gap identified covers a wide range of skills areas of which numerical skills are accepted to be significant. The reflection on these studies coalesces the analysis into an agreement about the dichotomy that exists between higher education providers and their clients. Numerical skills and other employability assets able graduates to operate professionally within

the managerial environment of the “learning age” (Maxwell et al., 2009). In the same perspective, Carvalho & Rabechini (2015) have emphasised the requisite for both soft and hard skills in contemporary management practice. These should be gained prior to entering management given the intense pressure modern managers are under to deliver outputs and meet demanding targets.

The role of higher education

Temple (2012) and Shaheen (2011) highlight the crucial role that higher education can play in skilling the nation and proposes a skills-based approach to the curriculum to effectively support economic growth. Temple (2012) contends that modern universities need to rise above the traditional teaching and research role, to locate their new position at the heart of regional development and regeneration. In approaching their new role, universities need to focus on graduate employability (Hernández-Fernaud, E. et al., 2017; Álvarez-González, López-Miguens & Caballero, 2017) and create graduates who can articulate basic skills, including numeracy and literacy. In the same perspective, Mason, Williams and Cranmer (2009) found that numeracy is one of the greatest graduate employability assets. To develop such assets, the authors acknowledge the instrumentality of employer involvement in higher education curriculum design. From a utilitarian standpoint, employer involvement will render curricula relevant and will enable universities to demonstrate their embeddedness in society and the locality (Purcell, 2008). A critical partnership between higher education providers and employers is parameter that can strengthen confidence in higher education’s ability to meet societal demand. Johnson & Peifer (2017) found evidence of decreasing confidence in university graduates, though varies according different social contexts. In another study on public faith in higher education institutions Hunsaker & Thomas (2014) also found decreasing public confidence in the higher education system. This implies that perceptions and expectations of higher education have experienced dramatic changes (p. 4) in the past three decades or so, which call up providers to re-examine their offering, the curriculum and the type of graduates they generate.

In a further damning report on higher education, Decatur (2017) goes further to talk about a crisis of confidence in higher education. Such a crisis derives from the perceived disconnect between higher education and its societal customers, chiefly employers but also parents whose expectations of the system have increased with regards to the employability of their graduate daughters and sons. Keep (2014), thus, foresees a greater and more dynamic role for universities and colleges in embracing skills-based higher education which is aligned with actual demand of the economy and the wider society.

Method

Design

The study's a between-groups design. Two groups of participants (a graduate and a non-graduate group) were selected from the residential weekend group and externally to experience the same conditions, i.e. perform a numerical test. The independent variable was level of qualification (graduate vs. non-graduate). It was assumed that the questions from the second part of the test (with multiplications of double digit numbers on either side) will be harder than those of the first part (with multiplications of one digit number on one side and a double digit number on the other). The dependent variables were rating of Confidence (expressed using the scale 50 - 100), percentage of right answers and Average of Correct Answers. The basic design did not set a specific time limit for participants to attend to the stimuli but they were strongly encouraged to respond to stimuli within 20 seconds). Responses that participants provided to each stimulus were at two levels: (1) answer TRUE/FALSE to suggest estimates to multiplication operations (2) estimate level of confidence about their answer. For instance a stimulus like $22 \times 31 = 650$ TRUE–FALSE; then (confidence = 70%).

Participants

The study participants were predominantly recruited from a group of part-time student managers attending a residential weekend. A participant group comprised 11 residential weekend students who were graduate managers in

various companies. The second group of participants comprised 11 respondents but those did not have a university degree. The groups were equal in number so as to enable reasonable comparisons.

Apparatus

Data analysis was through the SPSS software. The major analysis areas were: Overall confidence estimates of the participants' number skills abilities; Overall estimates of time taken to complete test; accurate/inaccurate answers per group; comparison between graduates and non-graduates and a two-way ANOVA. The results were plotted on a graph to make significance more visible. Descriptive statistics like averages, percentages, means, mode, significance, etc. were considered for data description and support comparative frameworks.

Procedure

Four introductory questions ask the participants their overall confidence with numbers (between 50 - 100), qualification, age, gender; the last question asks the participants to state the amount of time taken for the task. The main questionnaire's set as multiplication operations whose values are estimated alongside participants' confidence level about answers to the estimated value of multiplications. The test comprised 40 questions or stimuli each with question about estimate confidence level. The first part of the test comprised multiplications with one digit on one side and double digit on the other; the second comprised double digits on either side, e.g. $6 \times 79 = 550$, $22 \times 31 = 650$. The participants were thoroughly briefed for consent and were given the opportunity to withdraw at any time. Answers were anonymous to preserve confidentiality. Participants were asked not to use calculators and to provide estimates from memory. It was anticipated after piloting the questionnaire that the experiment would take 6 - 10 minutes, giving participants approximately 20 seconds/question.

Results

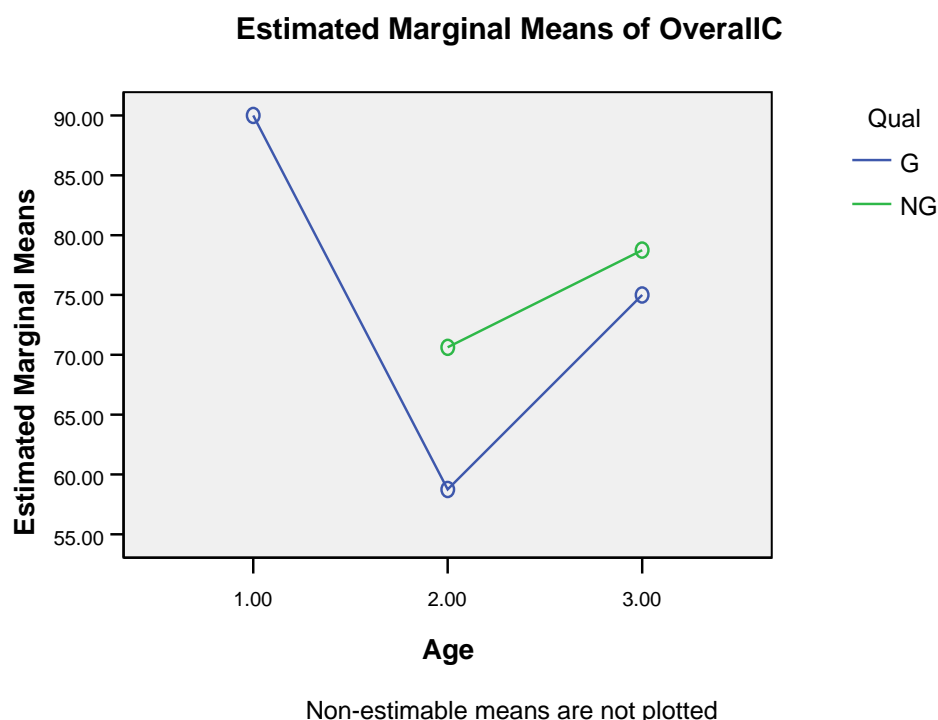
A between-subject ANOVA test was performed. The output supports the hypothesis that graduates overestimate their numerical skills confidence as a result of higher qualification levels. The significance level of the interaction term is $p = 0.305$, $d.f. = 1$ for Overall Confidence and $p = 0.542$, $d.f. = 1$ for Number of correct answers, which are well above 0.05. In this section, only significant aspects and graphs from ANOVA are examined. Table 1 summarises the main results, contrasting independent variable (Qualification, Age, Gender) with four dependent variables (Overall Confidence rating, Number of Correct Answers, No. Incorrect Answers and Time Taken).

Dependent Variable	Qual	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
OverallC	G	71.500(a))	5.138	60.401	82.599
	NG	74.688(a))	4.834	64.244	85.131
NrCorrA	G	23.000(a))	1.877	18.944	27.056
	NG	25.500(a))	1.767	21.683	29.317
NrIncorA	G	17.500(a))	2.123	12.914	22.086
	NG	14.500(a))	1.997	10.185	18.815
ConfPerQ	G	85.050(a))	4.528	75.267	94.833
	NG	87.125(a))	4.261	77.919	96.331
Time	G	14.550(a))	1.809	10.642	18.458
	NG	10.469(a))	1.702	6.791	14.146

(a) Based on modified population marginal mean

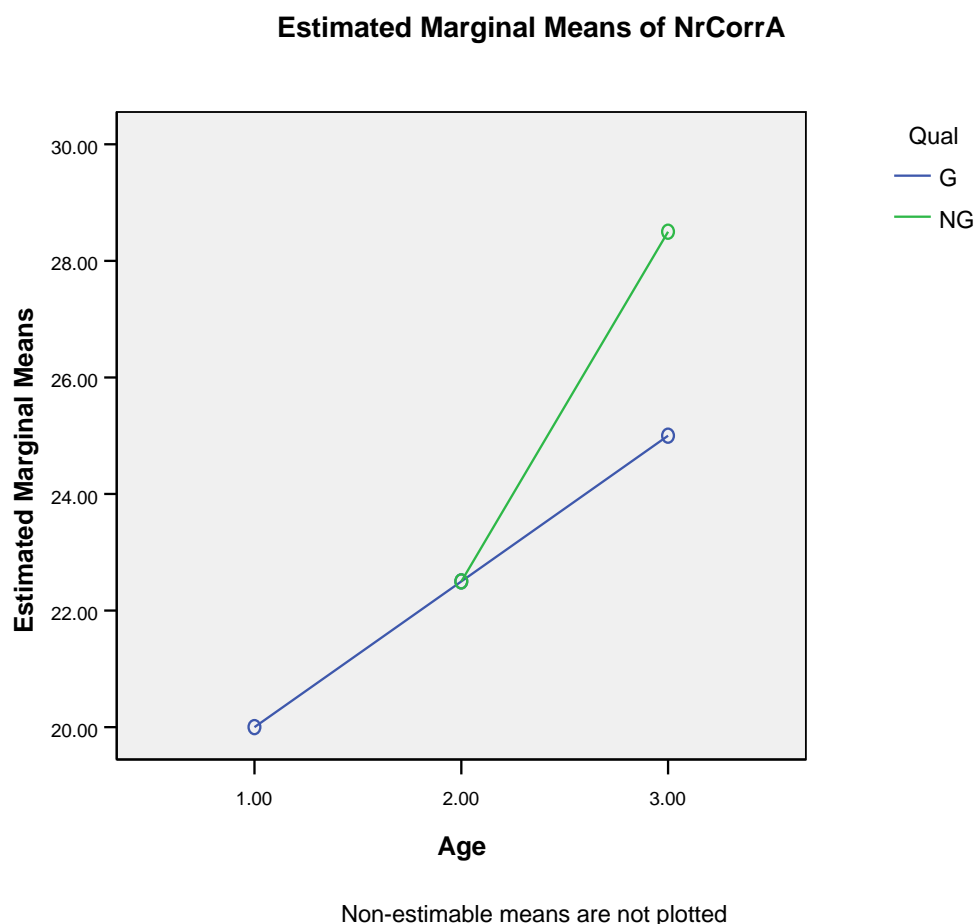
Table 1 Qualification*dependent variables

Overall graduates estimated their overall confidence in numerical skills lower than non-graduates. Younger graduates under 25 (age category 1) estimated their level of confidence above 90% while older graduates (age category 3 blue) averaged their confidence level (mean = 71.5%). This compares less favourably with non-graduates who were more confident about overall numerical skills confidence (Mean = 74.6%). However, the non-graduates actual results (test scores) were consistent with their expressed level of confidence and the test scores for graduates did not match their expressed level of confidence, thus suggesting overconfidence among graduates.



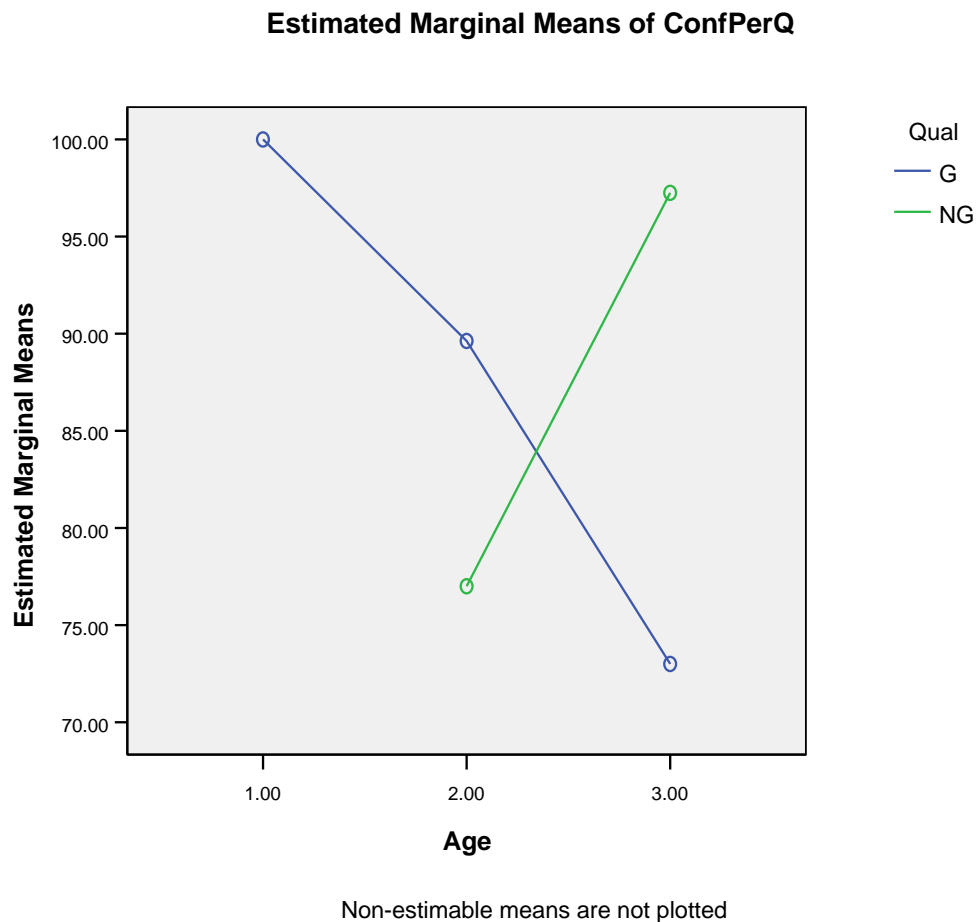
With number of correct answers (NrCorrA), non-graduates fared much better than their graduate rivals. Non-graduates achieved overall a minimum of 22/40 and a maximum of 28/40 right answers (Mean = 25). This compares highly to graduates who achieved 20/40 and 25/40 respectively (Mean = 23). When the

age factor is taken into account, Graph 2 shows that older participants in both qualification groups achieved much higher rate of correct answers compared to the younger participants. Typically, the higher ranges above were achieved by older participants, with older non-graduates outperforming older graduates (average 29 correct answers – versus - average 25 correct answers).

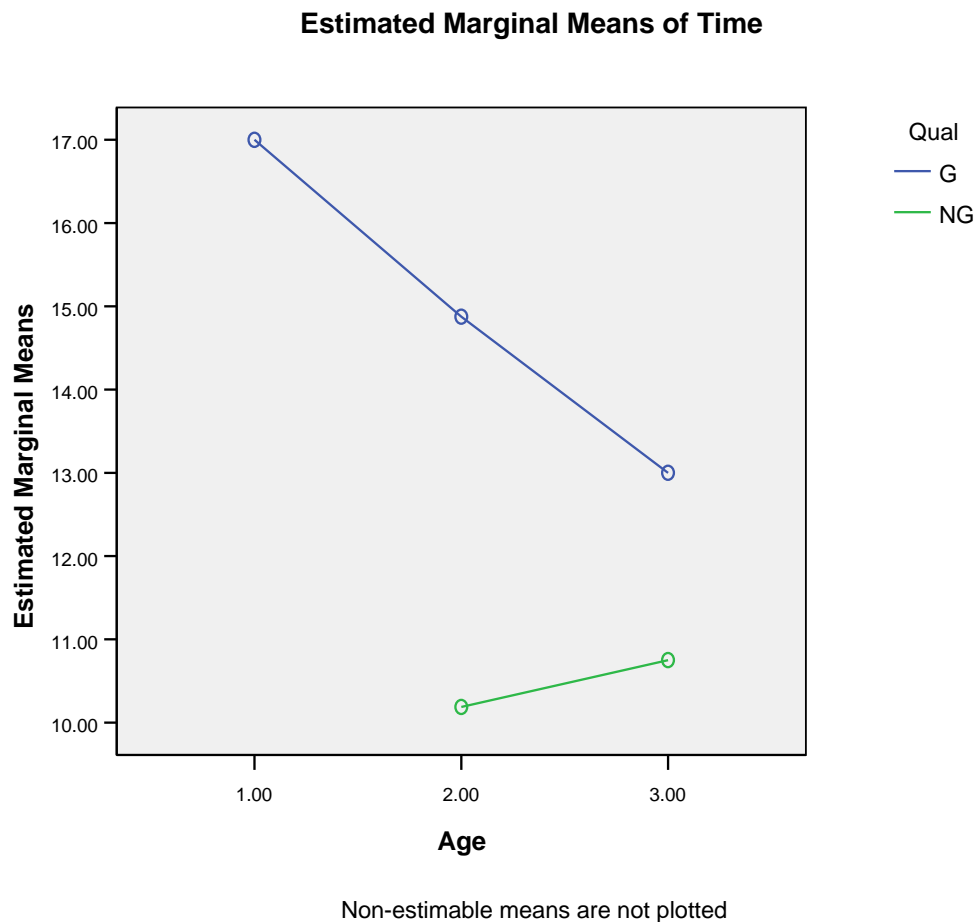


In average expressed confidence rating per question, graduates rated their confidence level lower, ranging from 70 - 100 per cent (Mean = 85). Again, non-graduates were more confident with their confidence rating, ranging from 75 - 97 per cent (Mean = 87). Younger graduates were more boastful about their confidence per question, often indicating ratings of 100%. But in contrast, older non-graduates rated their confident level higher than the younger non-

graduates (97 for over 40 year-olds compared to 77 for 25 - 40 year-olds) - See Graph 3.



A more significant level of contrast is observed when results are interpreted in terms of time taken. Graduates, unexpectedly, spent considerably more time than non-graduates. Graduates spent a minimum average of 14.5 minutes, with a maximum average of 18.5 minutes. Non-graduates took only on average 10.5 minutes and a maximum of 14.1 minutes to complete the tasks assigned. When the age factor is applied, there appears another significant contrast: younger graduates (age group 1), who had earlier expressed a higher confidence in their numerical skills, spent the longest (17 minutes maximum) to complete the task - See Graph 4.



Discussion

The research started with the following three hypotheses: (1) graduates are more likely than non-graduates to over-rate basic mathematical skills; (2) graduates' real basic mathematical skills can be lower than their skill estimates; (3) in a basic number test, graduates' performance may not be higher than non-graduates'. The general critical finding emerging from the data is that the performance of graduates in the experiment tasks was lower than that of non-graduates'; in general the performance of graduates was not commensurate with their estimate of numerical skills. These results support all the research hypotheses.

The findings confirm Harvey's (1997) view that people make judgements based on their assessment of themselves, with possible subjectivity, i.e. the confidence level expressed may not be reflected in the outcome of practical tests. In this experiment, the graduates estimated their numerical capabilities almost 20% higher than their test performance (confidence estimate = 71.5% compared with average achievement in test of just 57.5%). The results therefore show overconfidence in number skills among university graduates. Overconfidence here is based on Christensen-Szelanski & Bushyhead's (1981) theorisation, which asserted that in reality people do not know as much as they claim to. This is also evident in Malmendier & Tate's (2015) study of overconfidence in forecasting among CEOs. When presented with two elements of choice and asked to evaluate themselves in terms of certainty about answers, the tendency was a biased one, which means people rate their level of confidence higher than their actual performance is worth (Gigerenzer, Hoffrage & Kleinbolting (1991). In the context of our experiment, Gigerenzer, Hoffrage & Kleinbolting's (1991) theory also supported the findings for non-graduates, though to a lesser extent than it supported graduates'. With these slightly different results, one can argue that, while Gigerenzer, Hoffrage & Kleinbolting's (1991) framework could form an interesting starting point for the study of overconfidence, it cannot be an axiomatic prescription for our understanding of the phenomenon of overconfidence.

Though this is not apparent from the ANOVA test, because it has not been the focus of this test, manual analysis of the results shows that most wrong answers for graduates and non-graduates came in the latter part of the test (multiplication operations with double digits on either side). These multiplications were harder and attracted lower confidence ratings on the 50 - 100 scale. If this is confirmed in a separate ANOVA test, then, it would be plausible to argue that the findings also support Brunswik's (1955) Hard-Easy theory. The author argues that the extent of overconfidence is associated with the intricacy of the task; this means that overconfidence is generally lower as the questions to be answered present a greater degree of complexity. In other terms, people tend to become more objective about the assessment of their own capabilities when the questions that they are asked to answer become

harder. In a similar assessment, Sieck & Arkes (2005) investigating managerial decision-making, found that managers tended to be more complacent in decisions relating to routine matters as opposed to decisions about novel operations and situations.

The fact that graduates were overconfident could signify that graduates use the graduate status to legitimise and overrate their abilities. Similarly, Sieck & Arkes (2005) believed that more attention ought to be paid to the development of managers vis-à-vis routine decision-making. We can also put that despite graduate status, managers cannot be exempted from numeracy, literacy and leadership development programmes in work settings or educational environments. Within the same line of argument, Bullough, Renko & Myatt (2013) found that the development of managers at all times provides the opportunity for growing resilience and a greater entrepreneurial spirit.

The results of the study would confirm the degree of confidence in mass higher education and support studies of employers' perception and concerns about graduate employability as found in research by Hunsaker & Thomas (2014) and Temple (2012). This leads to decrease in business and parent confidence in higher education (Decatur, 2017).

Conclusion

In summary, the results demonstrate that as predicted graduates show overconfidence in numerical skills. There is a discrepancy between rating of their confidence and the actual performance in a simple numerical test. Being a graduate may lead people to overstate their general knowledge and numerical abilities than not being a university graduate. The findings support our hypotheses and Gigerenzer, Hoffrage & Kleinbolting's (1991) overconfidence theory proving that generally people pretend to know more than they actually do. The findings have critical curriculum and policy implications for British higher education institutions and learning and development managers in

organisations in the UK. Not only do the findings emphasise the critical importance of training and development in organisations (Harrison, 2011) but they also call for a degree of caution when addressing the learning and development needs of students in higher education and the professional development of employees in the British workforce. The results indicate that there is a need for equal emphasis on graduate and non-graduate manager training in organisations. The assumption that the graduate managers' higher level of qualification could exempt them from basic professional development activities has been rejected by the findings of the research. Learning and development provision requires democratisation in order to grow a more productive workforce. However, the stated issues with this experiment mean that the results should be taken with caution. Further research in the field would enable the formulation of more authoritative conclusions (Karadağ, 2017).

Given the evidence of this research and the survey findings by Kuczera, Field and Windisch (2016) exposing lower levels of numeracy among British graduates, we propose that higher education curricula make room for the teaching of numeracy by embedding it into curriculum design and delivery throughout the degree programmes. Employer input in curriculum design will also enhance the ability of higher education institutions to effectively address the skill gap (Mason, Williams & Cranmer, 2009; Purcell, 2008). Fallows and Steven (2000) contend that higher education has responsibility in employability skills development to "equip graduates with the skills to be able to operate professionally" (p. 76) – see also Temple (2012). Attaining this level of skills that match professional requisites require the input of organisations in terms of feedback about areas of critical skill deficiency in graduates as well as practical suggestions that would assist teaching institutions.

However, it is a simplistic view to place the entire onus on HEIs. It is equally important that organisations consider sharpening the numeracy and hard skill level of their graduate employees through systematic training programmes in the early period following hiring and through continuous professional development (CPD). Such early engagement with training needs and continuous follow-up could prepare the graduate workforce in routine and

complex decision-making (Bullough, Renko & Myatt, 2013; Sieck & Arkes, 2005), particularly in the management of projects, forecasting and the management of change.

The experiment produced some interesting results that largely supported the hypotheses. The research can be created for being one that provides actual measurement of graduate numeracy skills in relations to employers' perception that graduates have deficiencies in the area. However, weaknesses in the research need highlighting. For instance, future studies could consider a larger sample in order to arrive at more confident generalisations. Future experiments of this nature could also use a diversity of numeracy tests as opposed to the single frame (multiplication) adopted here. In addition, a more reliable tool for recording actual response time in the test would enhance the accuracy of the results. In that sense, the use of latest versions of sophisticated software could offer some advantages with greater recording and accuracy of the analysis. These could aid the quantification of the actual numeracy skills gap that both employer surveys (Hunsaker & Thomas, 2014; Karadağ, 2017; Kuczera, Field and Windisch, 2016) and this study have uncovered. Such an approach of research would go some way to restore confidence (Johnson & Peifer, 2017) in the ever expanding higher education system. In addition, such research will assist tertiary education institutions to develop learning platforms and programmes that create graduates who are not only competitive locally but also in the increasingly ruthless international labour market.

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